



# Development and Formulation of Carrot Kimchi

By

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## Abstract

Carrot kimchi is a choice of ready-to-eat food providing health benefits. The basic recipe of making ponytail radish kimchi from Maangchi (2012) was modified. The appropriate salting time before fermentation was 30 minutes. The final formula of kimchi carrot consisted of 74.5% carrot, 4.6% of salt, 1.2% of sugar, 2.2% of fish sauce, 0.9% of flour, 9.2% of water, 1.2% of onion, 1.3% of garlic, 1.3% of ginger, 2.3% of chili pepper, and 1.2% of go-chu jang. The mixture was fermented at 35-36°C for 48 hours. Texture analysis of this product revealed  $14123.23 \pm 4739.882$  g. of hardness and  $308.418 \pm 173.071$  of chewiness. Microorganisms that possibly found in carrot kimchi were *pseudomonas spp.* and *lactobacillus spp.* Carrot kimchi product has been survey by 92 consumers. Approximately 92% of consumers accepted this product and the average hedonic scores was  $6.7 \pm 1.4$  (like slightly toward like moderately). The acceptance price of carrot kimchi was lower than 25 baht.



# Table of Content

	Page
Table of content	iii
List of Tables	v
List of Figures	vi
Introduction	1
Objectives	3
Literature Review	4
Kimchi	4
History of kimchi	5
Health benefits of kimchi	7
Spontaneous fermentation	7
Lactic acid bacteria	7
Carrot	9
Beta carotene	10
Lutein and Zeaxanthin	10
Methodology	11
Materials	11
Methods	11

Development of basic formula of carrot kimchi	11
Physiochemical properties	13
Microbial Test	14
Consumer Acceptance Survey	15
Result and Discussion	16
Development of basic formula of carrot kimchi	16
Physiochemical properties	23
Microbial Test	24
Consumer Acceptance Survey	27
Conclusion	32
References	33
Appendix	34

## List of Tables

Table	Page
1     Nutritional composition of Typical Kimchi	8
2     The reference recipe for kimchi. (Maangchi, 2012)	11
3     Hedonic scores of kimchi carrot in different hours of fermentation.	19
4     Statistical analysis of hedonic scores for treatments with different amount of chili pepper added in kimchi carrot	23
5     Percent acidity as lactic acid of carrot kimchi	23
6     Textural attributes of carrot kimchi	24
7     Identification test of microbial flora in carrot kimchi	25
8     Consumer acceptance survey part1; the demographic information of consumer	27
9     Consumer acceptance survey part 2; the basic information of consumer's behavior	28
10    Consumer acceptance survey part 3; information of consumer's on carrot kimchi	30
11    Overall acceptance score (hedonic 9-point scale) for carrot kimchi	31



## List of Figures

Figure		Page
1	Chinese cabbage kimchi	4
2	Stone jar for making kimchi	6
3	Wild carrot ( <i>Daucus carota L.</i> )	9
4	Chemical structure of Beta carotene	10
5	Chemical structure of Lutein and Zeaxanthin	10
6	Just about right percentage of salting time before fermentation (a) for 30 minutes and (b) for 60 minutes	16
7	Just about right test with (a) 4.08% salt (b) 4.59% salt and (c) 5.2% salt	18
8	Just about right test after fermentation for (a) 24 hours (b) 48 hours and (c) 72 hours	20
9	Just about right test for addition of (a) 2.31% of chili pepper (b) 3.3% chili pepper (c) 4.29% of chili pepper and (d) 5.28% of chili pepper	22
10	Identification test of microbial flora in carrot kimchi (a) gram stain and (b) spore	25
11	Identification test of microbial flora in carrot kimchi (a) catalase test, (b) mobility test, and (c) aerobic test	26

# Introduction

Nowadays, people are interested in their health and appearance. Reference from an intensive exercise is become popular and healthy foods are also available in many groceries stores. In the global food trend, Asian foods are becoming popular in many countries accord with healthy food trend. Because Asian foods consist of vegetable and herbs that contain a lot of fiber which help lower blood glucose level that lead to obesity and diabetes. They also provide antioxidants, vitamins and minerals, such as vitamin A, zinc and vitamin C that prevent cellular damage and may inhibit the formation of cancerous tumors. In addition, one of the most famous and well-known Asian foods is Kim chi.

Kimchi is a traditional fermented Korean vegetable food. The major raw material for kimchi is cabbage, but many other vegetable are also used for making kimchi. Kimchi is a unique fermented vegetable product, depending on raw ingredient. Traditional kimchi can be classified into four catagories: vegetable cured with soy sauce and vinegar; vegetable cured in a high concentration of salt; vegetable fermented with grains; and vegetable fermented with salt, spices, and other ingredients. Kimchi preserve the organoleptic and nutritional properties from vegetable and fermentation. During ripening, unsterilized materials leads to the growth of lactic acid bacteria (LAB) which develop the taste and sensory of kimchi product. Lactic acid bacteria (LAB) also are the key role of beneficial effect of kimchi.

In Thai market, Korean kimchi is known only cabbage base kimchi but there are various categories of kimchi. This could be a chance to develop a new variety of kimchi product, by using carrot as a major raw material which is available all seasons in Thailand. Carrot is a long round shape vegetable. The

use part of carrot is taproot which is appearing in orange color. An orange color comes from a high concentration of beta-carotene, a precursor of vitamin A help to develop good eyes health. Also, a colorful carrot gives rise of chance to help children eat their vegetable.

This project aims to develop carrot Kim chi which is convenient and still have beneficial of Kim chi. Using carrot as a main ingredient can bring color and more nutrition to the product. A suitable process for development of carrot Kimchi was investigated and consumer acceptance for this product was studied.





## Objectives

1. To develop and formulate carrot kimchi recipe which suitable for Thai people
2. To identify the normal flora found while fermenting carrot kimchi.
3. To investigate the consumer's behavior toward carrot kimchi



## Literature Review

### Kimchi

Kimchi is a unique and traditional fermented vegetable food. It is mostly made from Chinese cabbage or radish but other type of vegetable also used as a major raw material, such as cucumber and green onion. There are many types of kimchi from different ingredients added and preparing method. The traditional method would make by salting the major ingredient, blend with seasoning and spice, and fermenting with lactic acid bacteria. Kimchi contain more than 200 species of bacteria and yeast which provide beneficial probiotics and essential vitamin from fermentation process. (Raymond, 2016)

Also, kimchi has unique taste and aroma although; there are share similar ingredients to another version of pickled cabbage. The unique taste and aroma of kimchi come from Korean chili pepper that make kimchi different from other types of fermented vegetable. They can be classified 5 tastes from kimchi; salty, sweet, bitter, sour, and spicy while other types of pickled cabbage taste like a salt pickled vegetable. (Korean Spirit and Culture Promotion Project, 2008)



Figure 1: Chinese cabbage kimchi



Korean people consume kimchi about 50-200 grams every day and the kimchi production estimated to 1,500,000 M/T in 2000 for commercial produce. There are various type of kimchi available in Korea, can be classified into two groups of kimchi. Kimchi without adding water include *baechu kimchi* (diced Chinese cabbage), *tongbeachu kimchi* (whole Chinese cabbage), *yeolmoo kimchi* (young Oriental radish), and *kakdugi* (cube radish). Kimchi with water adding include *baik kimchi* (diced Chinese cabbage), *dongchimi* (whole radish kimchi), *nabak kimchi* (cut radish and Chinese cabbage). (Mheen, 1984)

In addition, kimchi being fermented by various microorganisms at initial that naturally present from raw materials but the major microorganism that produce characteristic of kimchi is lactic acid bacteria (LAB). Lactic acid bacteria can convert sugar into lactic acid, CO<sub>2</sub>, and ethanol to provide texture and taste of kimchi and produce inhibition substance to inhibit the growth of unwanted microorganisms.

During fermentation of kimchi, many characteristics of kimchi being produced include compositional change of sugar and vitamins. Nutritionally, kimchi is an important source of vitamins, minerals, fiber, nutrients, organoleptic properties, and health related function.

## History of Kimchi

In an ancient time, people were trying to survive during the worst times. Many Asian countries experienced cold weather such as China, Japan, and Korea. They could not grow any plant and run out of food supplied during winter. China is the first country indicated vegetable preservation. They added salt to the vegetable and left they ferment without any culture added. (Chung *et al.*, 2015)



Many recorded about fermented vegetable was indicate since 17<sup>th</sup> century by preparing it in stone pickled jar and kept under the ground during winter time while food supply was limited. Kimchi was developed from Chinese *paochai* and appeared in white then change into red in 1592 by addition of red pepper. Korea had kimchi as a traditional food for thousands of years. (Park & Cheigh, 1994)



Figure 2: Stone jar for making kimchi

Han *et al.* (2010) investigated American's perception and preference for Korean kimchi focus on Illinois and California. The most accepted kimchi products were kimchi dumplings, kimchi pizza, kimchi bacon roll, kimchi fried rice, and kimchi chicken a'laking.

Ko *et al.* (1994) developed software for control system and storage of kimchi fermentation. The different times during fermentation gave significantly different taste judging from sensory evaluation.



### Health benefits of kimchi

Kimchi is vegetable base raw materials. It is an importance source of vitamins, kimchi contain carotene which is come from raw materials such as carrot, onion, and other vegetables. Also, some vitamins contain in kimchi is synthesize during fermentation period include vitamin B, and C. Moreover, kimchi also being an importance source of minerals and other nutritionals, protein, and dietary fiber. The amount of protein or amino acid present in kimchi is high, compared with other fermented vegetable. In addition, vegetable base raw materials of kimchi and probiotic from fermentation process help to improve intestinal and digestion and pharmaceutical functions. (Kim, 1985; Park & Cheigh, 1994)

### Spontaneous Fermentation

Fermentation process of kimchi will occur naturally by bacteria from raw materials. Various microorganisms will grow initiative, but the important bacterium is lactic acid bacteria (LAB). Lactic acid bacteria develop the texture, aroma, and unique taste of kimchi. Chemical, physical, and biological factor can help in microorganism growth but the important factors that affect kimchi are microorganism, salt concentration, pH, temperature, and oxygen. (Kim *et al.*, 1991)

### Lactic acid bacteria

Lactic acid bacteria are gram-positive, non-spore forming, and lack of catalase. They grow anaerobically and non-motility. Lactic acid bacteria converted glucose to lactic acid, CO<sub>2</sub>, and ethanol. They provide taste and texture to fermented food and inhibit spoiled bacteria by produce growth inhibiting substance. (Todar, 2011)

Table 1: Nutritional composition of Typical Kimchi (per 100 g. of Edible Portion) (Suweon, 1981)

Component	Chinese cabbage kimchi
Moisture (g)	88.4
Crude protein (g)	2.0
Crude lipid (g)	0.6
Total sugar (g)	1.3
Crude fiber (g)	7.2
Crude ash (g)	0.5
Calcium (mg)	28
Iron (mg)	Trace
Vitamin A (IU)	492
Vitamin B <sub>1</sub> (mg)	0.03
Vitamin B <sub>2</sub> (mg)	0.06
Niacin (mg)	2.1
Vitamin C (mg)	12



## Carrot



Figure 3: Wild carrot (*Daucus carota* L.)

Carrot (*Daucus carota* L.) is a root vegetable first use as medical purpose and gradually use as food. Carrot is an importance crop from *Apiaceae* family, it was indicated from the European record that carrot was first cultivated as yellow color. The color of carrot could be white, yellow, orange, red, purple, or dark purple but orange color was more popular. Carrot is sweet and crunchy with minty aroma (Dias, 2014)

Additionally, Anthocyanin and carotenoids are the major antioxidants found in carrot. Orange carrot is a rich source of provitamin A from phytochemical called  $\beta$  -carotene. They both are essential for eyes health and improve night vision. Carotenoids are concentrating in macula, which is part of retina and function as UV absorbance, natural sun block and absorb blue light. Carrot provides vitamin a and high bioavailability of carotenoid, comparing with other vegetable. Carrot contains dietary fiber and of the trace mineral molybdenum, rarely found in many vegetable. Anthocyanin and carotenoids are the major antioxidants found in carrot, can prevent free radical damage. (Dias, 2014)



**Beta carotene:** Phytochemical mostly found from colorful fruit and vegetable which can convert into vitamin A. Beta carotene is one of naturally compound called carotenoid, that important for improve vision and eyes cells. (Lixandru, 2014)

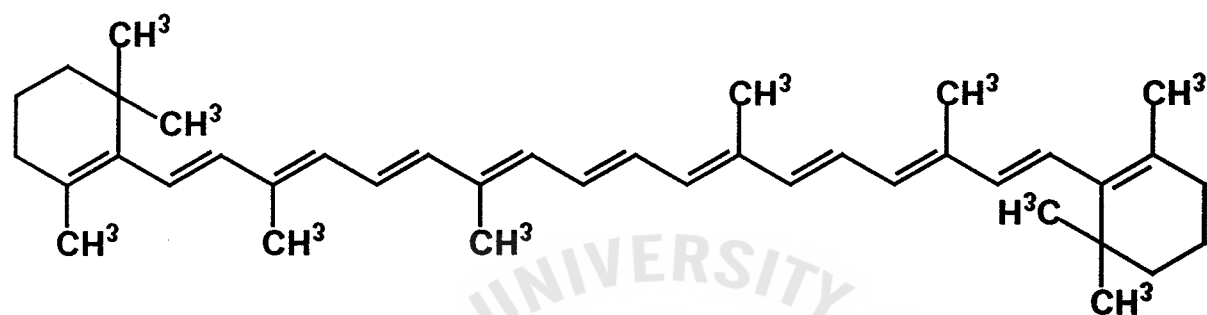


Figure 4: Chemical structure of Beta carotene

**Lutein and Zeaxanthin:** Phytochemical mostly found in colorful vegetable and green leaves vegetable such as kale and spinach. These two substances help prevent atherosclerosis and cancer. Lutein and Zeaxanthin possess powerful antioxidant properties and can protect all bodily cells against the damaging effects of free radicals. (Szalay, 2015)

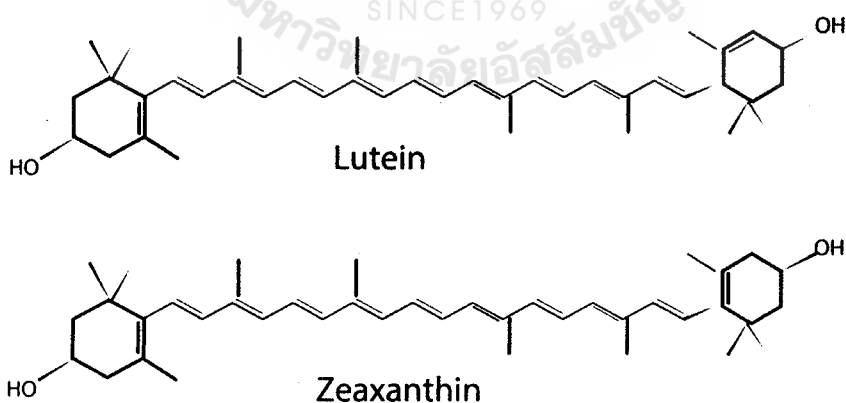


Figure 5: Chemical structure of Lutein and Zeaxanthin

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## Methodology

### Materials

Carrot, Salt, Sugar, Onion, Garlic, Ginger, Fish sauce, all-purpose flour were bought from the local market. Go-chu jang paste and Korea chili pepper were bought from supermarket.

### Methods

#### 1. Development of basic formula of carrot kimchi

TABLE 2: The reference recipe for kimchi was shown below (Maangchi, 2012).

Ingredients	Percentage
Ponytail radish	73.2
Salt	5.2
Sugar	1.15
Fish sauce	2.3
Flour	0.89
Water	9.08
Onion	1.2
Ginger	1.3
Garlic	1.3
Chili pepper	3.3
Go-chu jang	1.15

First of all, fresh carrots were cut into 1 cm. thick and 1 inches long. Then, carrot sticks were salting with salt for about 30-60 minutes until soft and release some water out. Rinsed carrot sticks with water to remove an excess salt. After that, ginger, garlic, and onion were chopped into fine pieces and mixed with all the remaining ingredients. Finally, kimchi mixture was left in a closed container at room temperature for about 24 hours to ferment.

#### **2.1 Study on suitable salting time before fermentation**

The salting time was studied by varying 30 minutes and 60 minutes soaking carrots with salt to observe the different texture of carrot sticks. The just-about-right test (size of carrot, kimchi aroma, sourness, spiciness, and crunchiness) was chosen to be evaluated by 15 panelists.

#### **2.1 Study on the optimum of salt added for fermentation**

The amount of salt used for fermentation was determined by varying 5.2% (from table 2) of salt, 4.59% of salt (10% less), and 4.08% of salt (20% less). The just-about-right test (size of carrot, kimchi aroma, sourness, spiciness, and crunchiness) was chosen to be evaluated by 15 panelists.

#### **2.1 Study on fermentation process of carrot kimchi.**

The fermentation was allowed for 3 days at room temperature. At the end of each day, carrots were sampling for the just-about-right test (kimchi aroma, sourness and spiciness). The room temperature was recorded every day. The experiment was repeated in triplication.



## 2.1 Study on the amount of chili pepper added that affects on spiciness.

The spiciness of kimchi was studied by varying 4 different amount of chili pepper flake which were 0.623% (30% less), 0.89% (from table 2), 1.157% (30% more), and 1.424% (60% more). The just-about-right kimchi aroma, sourness and spiciness) and sensory evaluation (9-point hedonic score) test were chosen to be evaluated by 15 panelists.

## 2. Physiochemical properties

### 2.1 % Acidity

A few drops of phenolphthalein were added into 10 ml kimchi juice solution and titrate with 1 N. of sodium hydroxide. The amounts of sodium hydroxide were recorded and calculate % acidity from the formula.

$$\% \text{ Lactic acid} = \frac{\text{mol NaOH} \times V \text{ NaOH (ml.)} \times \text{MW} \times 100}{1000 \times V \text{ Sample (ml.)}}$$

### 2.2 Texture analysis

Kimchi texture was analyzed using a TA-XT plus texture analyzer (stable microsystems, U.K.). Kimchi sticks were cut into 1×1 cm thick with 2 inches long. Each piece of kimchi was subjected to chew using a P2-5 mm cylinder probe, Warner Blatzler blade, and a 50 kg load cell. The test speed was set to 1 mm/s. Firmness, toughness, hardness, springiness, cohesiveness, and chewiness were recorded. (Chang *et al.*, 2010)

### **3. Microbial Test**

#### **3.1 Gram stain**

The colony of sample was smear on a glass slide and dye with gram's crystal violet, gram iodine, and safranin for about 1 minute of each dye. A sample dyed slide was observed under an oil immersion lens.

#### **3.2 Spore stain**

The colony of sample was smear on a glass slide and dye with malachite green about 5 minutes; this was difficult to dye the spore inside a cell so it needed to dye above boiling water to help dyeing process easier. Then, dye with Safranin for about 1 minute. A sample dyed slide was observed under an oil immersion lens.

#### **3.3 Aerobic and Facultative anaerobic test**

The bacteria were inoculated by needle and grow in NA agar tube which was covered with glycerol. Incubate for 24 hours at 37°C.

#### **3.4 Catalase test**

Sample solution was smear on TSA slant and incubated for 24 hours at 37°C. After that a few drops of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) were added and observed the result.

#### **3.5 Mobility test**

The bacteria of sample were stabbed on the center of NA agar plate and grow at 37°C for 24 hours. Then observed the results and recorded.

#### **4. Consumer Acceptance Survey**

The carrot kimchi was fermented for 48 hours and asked for consumer acceptance survey. Ninety-two consumers were surveyed at Siam Square. The questionnaire used in this part was divided into three parts. The first part was demographic information of consumer. The second part was the basic information of consumer's behavior on fermented vegetable in the market. The final part was information of consumer's on carrot kimchi.





# Results and Discussion

## 1. Development of basic formula of carrot kimchi

### 1.1 Study on suitable time for salting before fermentation.

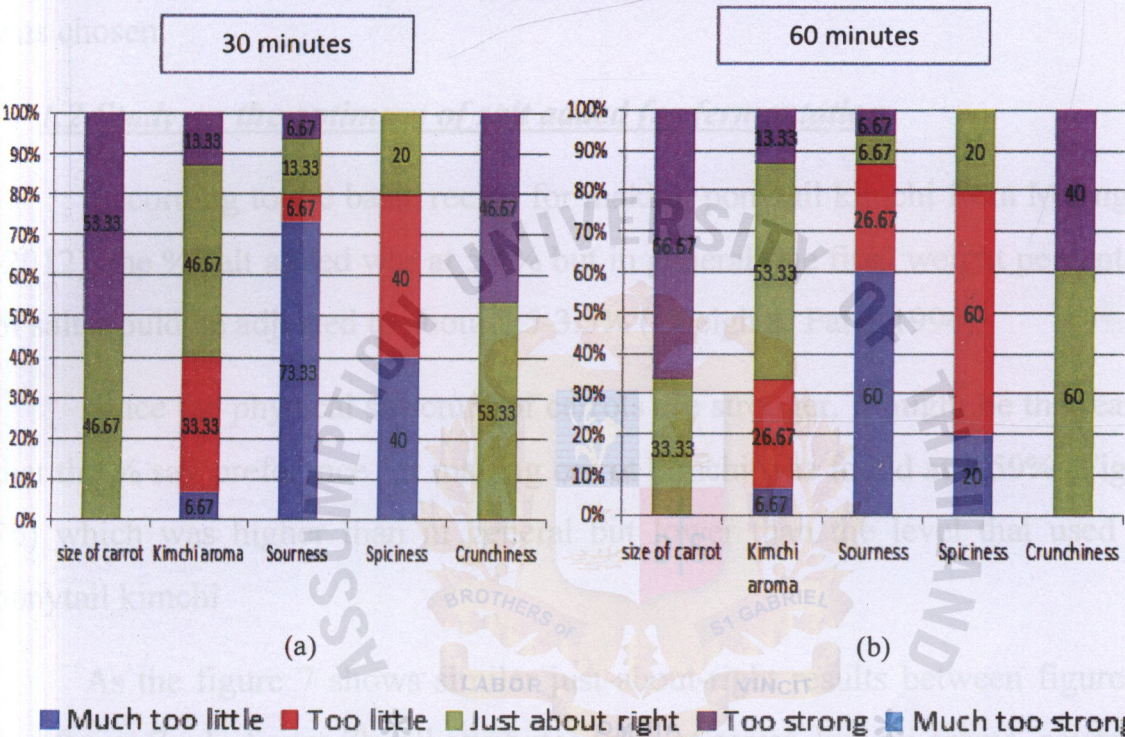


Figure 6: Just about right percentage of salting time before fermentation (a) for 30 minutes and (b) for 60 minutes

The result showed that consumers saw that similarity in size of carrot, kimchi aroma, spiciness, and chewiness. The sample with 30-min salting time (Figure 6a) showed the percentage of people said just about right were 46.67% size of carrot, 46.67% kimchi aroma, 13.33% sourness, 20% spiciness, and 53.33% crunchiness. On the other hand, the sample with 60-min salting time (Figure 6b) the percentage of people said just about right were 33.33% size of carrot, 53.33% kimchi aroma, 6.67% sourness, 20% spiciness, and 60% crunchiness.



For sourness, the sample with 30-min salting time gave more percentage of people said just about right than the sample with 60-min salting time. This could be because too much salting inhibited the growth of essential bacteria for fermenting kimchi and the sourness was detected as too little for sample with 60-min salting time. In conclusion, salting time for 30 min before fermentation was chosen.

### **1.2 Study on the optimum of salt added for fermentation**

According to the basic recipe for making ponytail kimchi from Maangchi (2012), the % salt added was at 5.1% but in general, the final weight percentage of salt would be adjusted to about 2.5-3.5% (Cheigh & Park, 1994).

Since the physical structure of carrots are stronger, it might be the reason that the % salt preference for making carrot kimchi was found at 4.59% (Figure 7b) which was higher than in general but lower than the level that used for ponytail kimchi

As the figure 7 shows similar just-about-right results between figure 7b and figure 7c. In figure 7b, all attributes (size of carrot, kimchi aroma, sourness, spiciness, and crunchiness) are shown in the percentage of just about right that were 66.67% size of carrot, 53.33% kimchi aroma, 33.33% sourness, 33.33% spiciness, and 73.33% crunchiness. In figure 7c, it showed the percentage of just-about-right were 40% size of carrot, 53.33% kimchi aroma, 26.67% sourness, 46.67% spiciness, and 40% crunchiness. In conclusion, the 4.59% salt (Figure 7b) was chosen because less amount of salt added provided just right crunchiness as well.



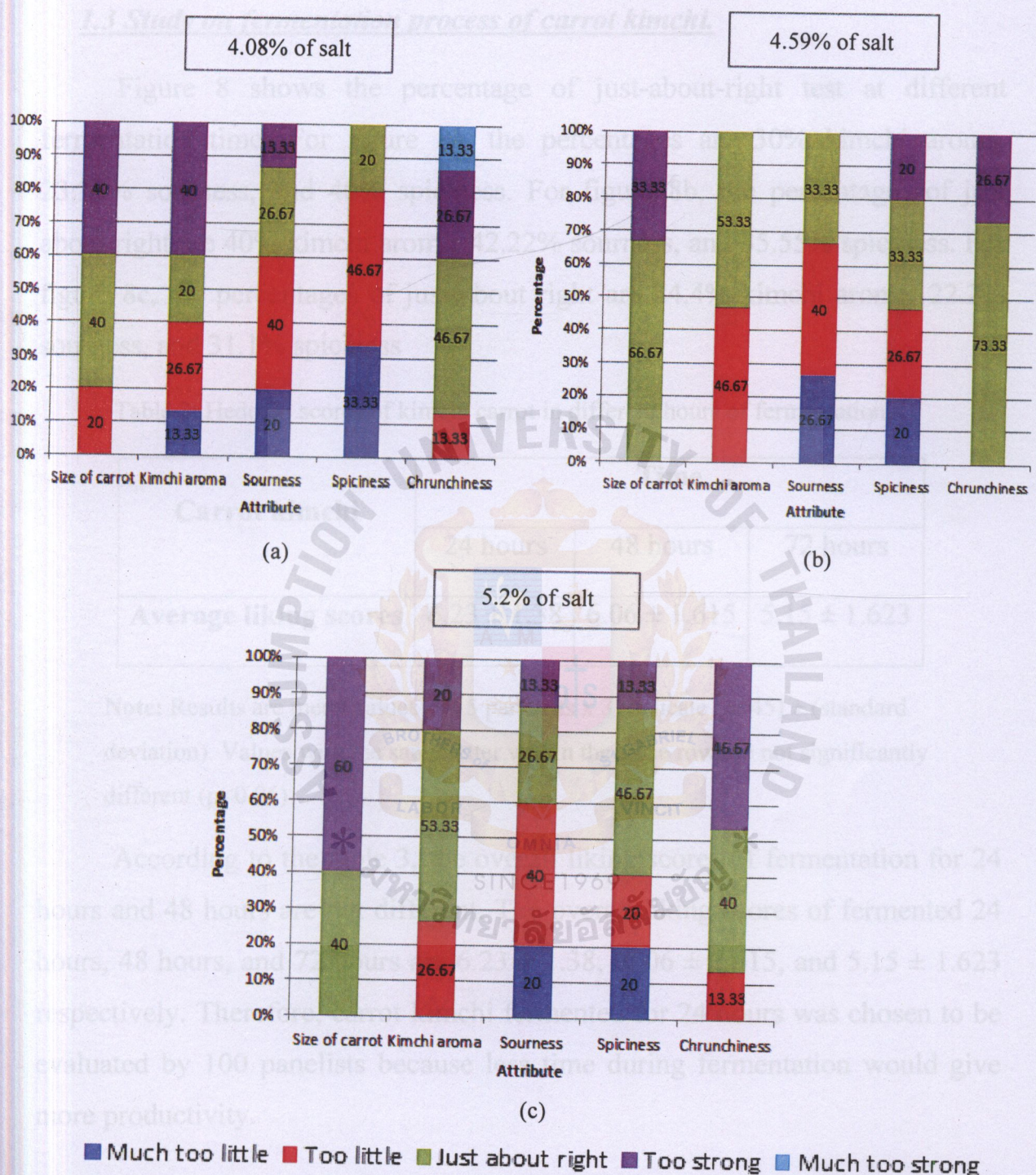


Figure 7: Just about right test with (a) 4.08% salt (b) 4.59% salt and (c) 5.2% salt



**1.3 Study on fermentation process of carrot kimchi.**

Figure 8 shows the percentage of just-about-right test at different fermentation time. For figure 8a, the percentages are 30% kimchi aroma, 23.33% sourness, and 40% spiciness. For figure 8b, the percentages of just about right are 40% kimchi aroma, 42.22% sourness, and 35.55% spiciness. For figure 8c, the percentages of just about right are 24.4% kimchi aroma, 22.2% sourness, and 31.1% spiciness

Table 3: Hedonic scores of kimchi carrot in different hours of fermentation.

Carrot kimchi	Time		
	24 hours	48 hours	72 hours
Average liking scores	6.23 ± 1.38	6.06 ± 1.615	5.15 ± 1.623

**Note:** Results are mean values of 15 panelists x 3 replicate (n=45) ± (standard deviation). Values with the same letter within the same row are not significantly different (p<0.05)

According to the table 3, the overall liking scores of fermentation for 24 hours and 48 hours are not different. The overall liking scores of fermented 24 hours, 48 hours, and 72 hours are 6.23 ± 1.38, 6.06 ± 1.615, and 5.15 ± 1.623 respectively. Therefore, carrot kimchi fermented for 24 hours was chosen to be evaluated by 100 panelists because less time during fermentation would give more productivity.

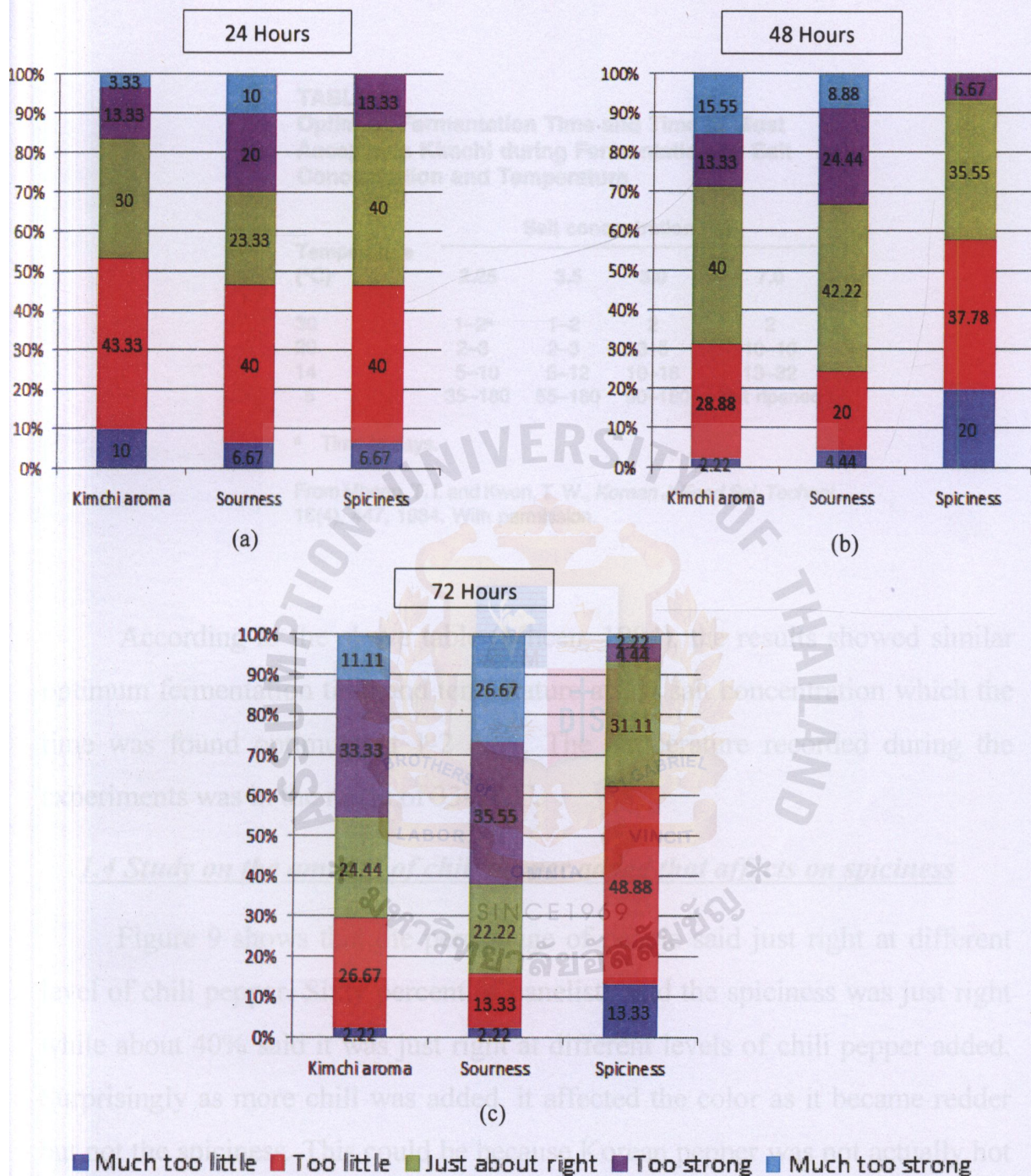


Figure 8: Just about right test after fermentation for (a) 24 hours (b) 48 hours and (c) 72 hours



**TABLE 4**  
**Optimum Fermentation Time and Time to Most**  
**Acceptable Kimchi during Fermentation by Salt**  
**Concentration and Temperature**

Temperature (°C)	Salt concentration (%)			
	2.25	3.5	5.0	7.0
30	1-2*	1-2	2	2
20	2-3	2-3	3-5	10-16
14	5-10	5-12	10-18	13-32
5	35-180	55-180	90-180	Not ripened

\* Time in days.

From Mheen, T. I. and Kwon, T. W., *Korean J. Food Sci. Technol.*,  
16(4), 447, 1984. With permission.

According to the above table (Mheen, 1984), the results showed similar optimum fermentation time and temperature at 5% salt concentration which the time was found optimum at 1-2 days. The temperature recorded during the experiments was in the range of 33-37°C.

#### **1.4 Study on the amount of chili pepper added that affects on spiciness**

Figure 9 shows that the percentage of people said just right at different level of chili pepper. Sixty percent of panelists said the spiciness was just right while about 40% said it was just right at different levels of chili pepper added. Surprisingly as more chili was added, it affected the color as it became redder but not the spiciness. This could be because Korean pepper was not actually hot nor spicy.

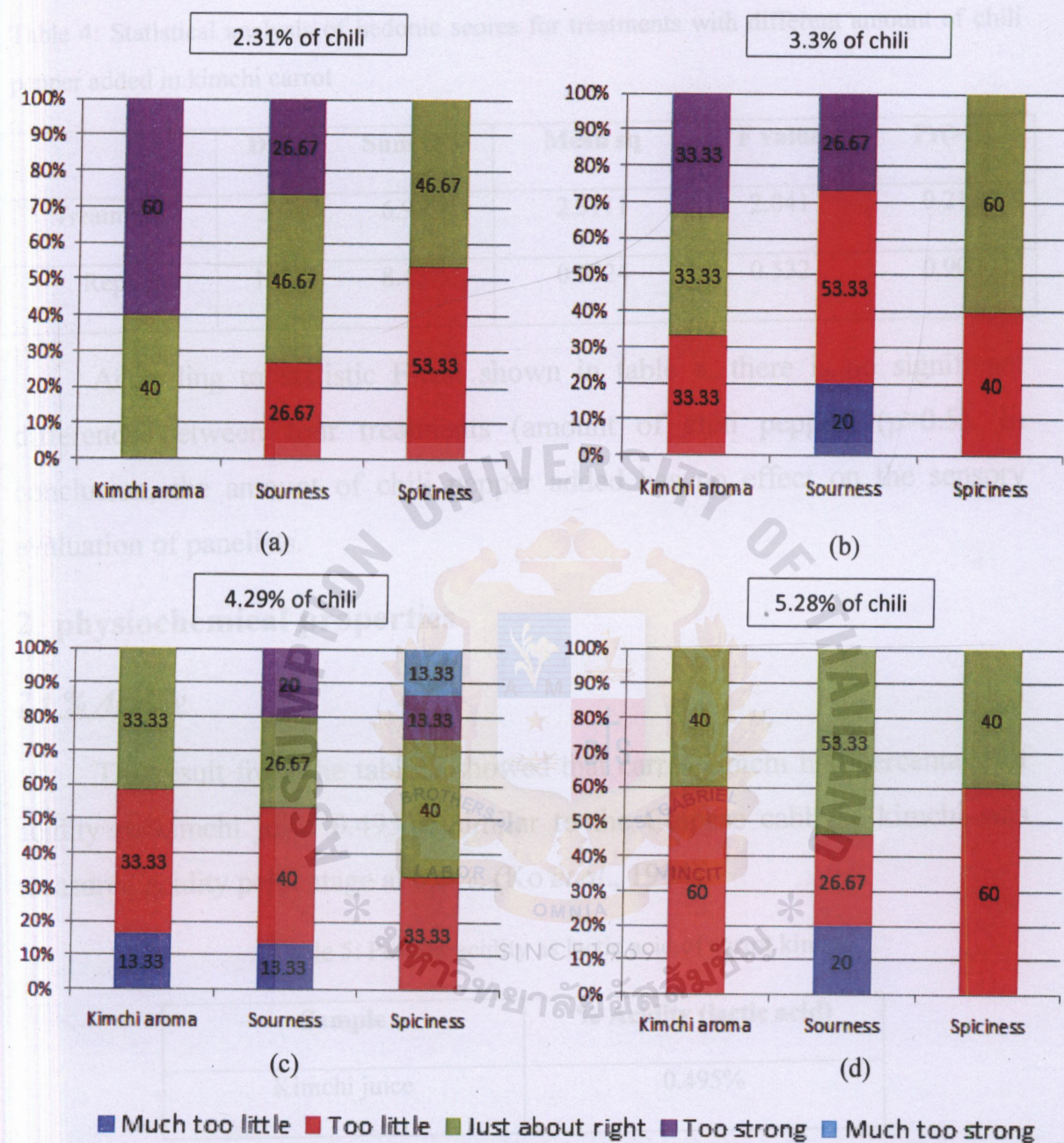


Figure 9: Just about right test for addition of (a) 2.31% of chili pepper (b) 3.3% chili pepper (c) 4.29% of chili pepper and (d) 5.28% of chili pepper



Table 4: Statistical analysis of hedonic scores for treatments with different amount of chili pepper added in kimchi carrot

	DF	Sum sq	Mean sq	F value	Pr(>F)
Treatment	3	6.93	2.3111	2.041	0.213
Rep.	14	8.43	0.6024	0.532	0.900

According to statistic F-test shown in table 4, there is no significant difference between four treatments (amount of chili pepper) ( $p>0.5$ ). In conclusion, the amount of chili pepper added has no effect on the sensory evaluation of panelists.

2. physiochemical properties

2.1 % Acidity

The result from the table 5 showed that carrot kimchi had percentage of acidity in kimchi juice 0.495%, similar to the Chinese cabbage kimchi was measured acidity percentage at 0.6%. (Ko *et al.*, 1994)

Table 5: Percent acidity as lactic acid of carrot kimchi

Sample	% Acidity (lactic acid)
Kimchi juice	0.495%

2.2 Texture Analysis

Table 6 shows the different texture attributes of carrot kimchi. The attributes which were firmness, toughness, hardness, springiness, cohesiveness, and chewiness were analyzed by texture analyzer



Table 6: Textural attributes of carrot kimchi

Attributes	Force
Firmness (g)	2647.8 ± 1194.373
Toughness (g·sec)	15927.039 ± 4926.828
Hardness (g)	14123.23 ± 4739.882
Springiness	0.302 ± 0.056
Cohesiveness	0.094 ± 0.12
Chewiness	308.418 ± 173.071

The result showed that the forces were used for measured all attributes are 2647.8±1194.373g. Firmness, 15927.039±4926.828g·sec of toughness, 14123.23±4739.882g. Hardness, 0.302±0.056 springiness, 0.094±0.12 cohesiveness, and 308.418±173.071 chewiness. Chang & Chang (2010) studied the texture of cabbage kimchi which showed similarity in hardness (2868.56 g) and chewiness (350.45).

### 3. Microbial test

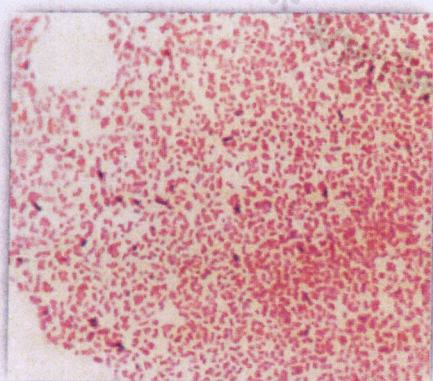
The result of microbial test was shown in the table 7. The bacteria found in kimchi were gram-stained and it showed the figure of gram positive and gram negative type bacteria (Figure 10). There were no stains with malachite green indicating no spore found and lack of catalase. The bacteria grew anaerobically and non-motility.

Table 7: Identification test of microbial flora in carrot kimchi

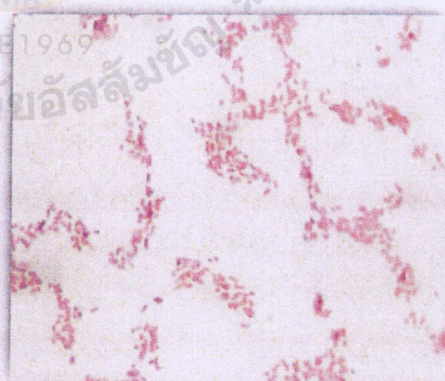
Test	Result
Gram stain	Positive/Negative
Spore stain	Negative
Catalase test	Negative
Aerobic and Facultative anaerobic test	Negative
Motility test	Negative

The microorganisms involved in kimchi fermentation include about 200 species of bacteria and several yeasts. The major bacterium is Lactic acid bacteria but also found *Pseudomonas* specie (Cheigh & Park, 1994). Furthermore, various microorganisms from materials may be involved in the fermentation.

Figure 10: Identification test of microbial flora in carrot kimchi (a) gram stain and (b) spore



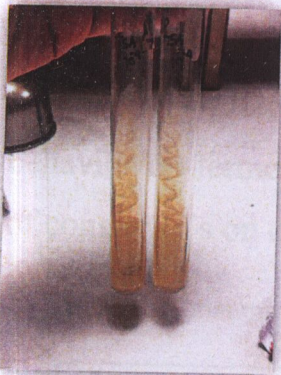
(a) Gram stain



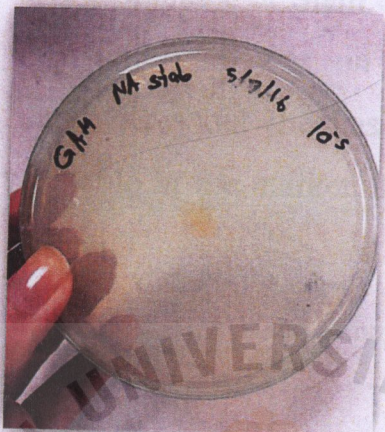
(b) Spore stain



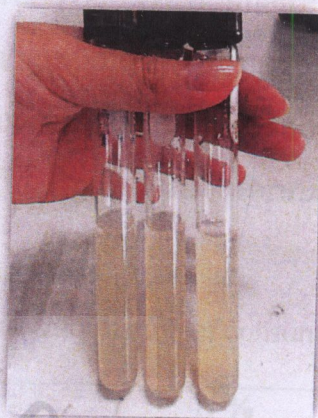
Figure 11: Identification test of microbial flora in carrot kimchi (a) catalase test, (b) mobility test, and (c) aerobic test



(a) Catalase test



(b) Motility test



(c) Aerobic and Facultative Anaerobic test



#### 4. Consumer Acceptance

The consumer acceptance survey was created to ask 100 consumers. Ninety-two consumers were responded at Siam Square. The questionnaire was divided into 3 parts. The first part was on demographic information of consumer. The second part was about the basic information of consumer's behavior on fermented vegetable in the market. The final part was information of consumer's on carrot kimchi.

Table 8: Consumer acceptance survey; part1: the demographic information of consumer

Variable	Content	N %
Gender	Male	42
	Female	58
Age	Less than 20 years old	35
	20-29 years old	28
	30-39 years old	15
	40-49 years old	7
	50-59 years old	11
	60 years old and above	4
Occupation	Student	44
	Housewife	11
	Employee	19
	Teacher	4
	Government office	2
	Own business	6
	Other	13
Nationality	Thai	90
	Non-Thai	10
Income	Less than 5,000 baht	40

Variable	Content	N %
	5,000-10,000 baht	8
	10,001-15,000 baht	22
	More than 15,000 baht	30

The first part of questionnaire was demographic information (Table 8), and asked for investigate gender, age, occupation, nationality, and income per month. From the table above, 58% of consumers were female and 42% were male. Then, 35% of them were below 20 years old, 28% were in the rank of 20-29 years old, 15% were in the rank of 30-39 years old, 7% were in the rank of 40-49 years old, 11% were in the rank of 50-59 years old, and 4% were 60 years old and more. Moreover, 44% of consumers were student, 11% of consumers were housewife, 19% of consumers were employee, 4% of consumers were teacher, 2% of consumers were government office, 6% of consumers were had their own business, and 13% had other jobs. Most of them (90%) was Thai nationality and the remaining 10% was non-Thai nationality, while 40% of consumers had income lower than 5,000 baht per month, 8% of consumers had income 5,000-10,000 baht per month, 22% of consumers had income 10,001-15,000 baht per month, and 30% of consumers had income more than 15,000 per month.

Table 9: Consumer acceptance survey part 2; the basic information of consumer's behavior

Variable	Content	N %
Do you eat vegetable?	Yes	94
	No	6
Do you like to eat pickled vegetable?	Yes	60
	No	40

<b>Variable</b>	<b>Content</b>	<b>N %</b>
<b>What kind of pickled vegetable have you ever tried?</b>	Cucumber	32
	Cabbage	30
	Carrot	27
	Radish	11
<b>Have you had kimchi before?</b>	Yes	<b>81</b>
	No	19
<b>Where do you buy kimchi?</b>	Convenience store	<b>51</b>
	Supermarket	36
	Grocery store	5
	Local market	2
	In a Korean restaurant	2
	Other	4
<b>How often do you buy kimchi?</b>	Everyday	4
	Once per week	5
	2-3 times per week	2
	Once per month	19
	2-3 times per month	15
	Less than once per month	<b>55</b>
<b>If there is a new type of kimchi launch into the market, are you interested?</b>	Yes	<b>80</b>
	No	20

For the second part of consumer survey, it asked about consumer's behavior on carrot kimchi. As the result from table 9, 94% like to eat vegetable but 6% dislike. Furthermore, 60% of consumers liked to eat pickled vegetable while 40% disliked. Also, 32% had pickled cucumber, 30% had pickled cabbage, 27% had pickled carrot, and 11% had pickled radish by 81% of them had kimchi before and the remaining 19% never had kimchi. The consumers



(51%) bought kimchi from convenient store, 36% bought kimchi from supermarket, and the rest bought kimchi from grocery store (5%), local market (2%), Korean restaurant (2%), and other places (4%). The frequency of buying kimchi of consumers were 55% bought kimchi less than once per month, 19% bough kimchi once per month, 15% bought kimchi 2-3 times per month, 5% bought kimchi once per week, 4% bought kimchi every day, and 2% bought kimchi 2-3 times per week. For the last question of this part, it asked if there was a new type of kimchi launch into the market, would they be interested and 80% said that they were interested while 20% were not interested.

Table 10: Consumer acceptance survey part 3; information of consumer’s on carrot kimchi

Variable	Content	N %
Do you accept carrot kimchi?	Accept	92
	Not accept	8
Would you buy this product if it is sold in the market?	Yes	86
	No	14
What is your reasonable price for 50 grams of carrot kimchi for 8 sticks?	Lower than 25 baht	44
	26-35 baht	28
	36-45 baht	23
	More than 45 baht	5

According to the last part of consumer survey (Table 10), the consumers were asked about their behavior on carrot kimchi. Approximately 92% of consumers accepted this product and the remaining 8% did not accepted. Moreover, 86% of consumers would buy the product if it was launch in the market but 14% would not buy the product. When asked for the reasonable price for 50 grams (8 sticks) of carrot kimchi, 44% of respondents would buy if

it was lower than 25 baht. The percentage that would buy for 26-35 baht was 28%, 36-45 baht was 23%, and the more than 45 baht was 5%.

Table 11: Overall acceptance score (hedonic 9-point scale) for carrot kimchi

Carrot kimchi	Rating scales
Overall liking scores	6.7 ± 1.4

For the overall acceptance test, the consumers were given the carrot kimchi product and asked to rate the overall liking score. According to the result was showed above, the rating scales of overall liking score of carrot kimchi product was 6.7 ± 1.4 (like slightly toward like moderately).



## Conclusion

The final formula of carrot kimchi were consist of 74.5% of carrot sticks, 4.6% of salt, 1.3% of garlic, 1.3% of ginger, and 2.3% of chili pepper as a major raw materials. Also, 1.2% sugar, 2.3% fish sauce, 0.9% flour, 9.2% water, 1.2% onion, and 1.2% go-chu jang as minor raw materials. Carrot kimchi was fermented at 35-36°C for 24 hours before consumption and contain 0.495% acidity. Moreover, texture analysis of carrot kimchi was similar to that of the cabbage kimchi. The bacteria that possibly found in carrot kimchi were *Pseudomonas spp.* and *Lactobacillus spp.* Approximately 92% of consumers accepted this product and rated the hedonic score for  $6.7 \pm 1.4$  (Like slightly towards like moderately). The acceptance price of carrot kimchi was lower than 25 baht while the cost was about 8 baht.



## References

1. Chang J.Y., Chang H.C., 2010. Improvements in the Quality and Shelf Life of Kimchi by Fermentation with the Induced Bacteriocin-Producing Strain, *Leuconostoc citreum* GJ7 as a Starter. *Journal of food science*, vol. 75, Nr 2, 2016.
2. Cheigh H.S., Park K.Y. And lee C.Y., 1994. Biochemical, microbiological, and nutritional aspects of kimchi. *Critical Reviews in Food Science and Nutrition*, 34(2): 175-203
3. Chun jongsik, 2016. Bacterial community structure in kimchi, a Korean fermented vegetable food, as revealed by 16s rRNA gene analysis. *International Journal of food Microbiology*·August 2005. DOI: 10.1016/j.ijfoodmicro.2004.11.030·Source: PubMed.
4. Chung K.R., Jang D.J., Jang D.J., Yang H.J., 2015. Discussion on the origin of *kimchi*, representative of Korean unique fermented vegetables. *J Ethn Food* 2 126-136.
5. Dias S., 2014. Nutritional and Health Benefits of Carrots and Their Seed Extracts. *Food and Nutrition Sciences*, 5, 2147-2156.
6. Han, G.P., Han J.S., Lee J.S., Kim, Y.J., 2010. A Survey of American's Perception and Preference for Korean Kimchi: Focus on Illinois and California.
7. Kenneth Todar, pd, lactic acid bacteria <http://textbookofbacteriology.Net/lactics.Html>
8. Kim, S. S., Study on *Traditional Korean Foods*, Sookmyung Womens University, Seoul, 1985, 113.
9. Kim, S. S., Cheing, H. S., and Byun, K. W., *Food Processing and Preservation*, Soohaksa, Seoul, 1991, 342.
10. Ko Y.D., Kim H.J., Chun S.S., and Sung N.K., 1994. Development of Control System for *Kimchi* Fermentation and Storage Using Refrigerator. *KOREAN J. FOOD SCI. TECHNOL* vol. 26, No. 3, pp. 199~203
11. Korean Spirit and Culture Promotion Project. 2008. Korean Cuisine Full of Wisdom and Nature. Taste of Korea. <http://www.kscpp.net>
12. Lixandru M., 2014. Properties and Benefits of carrot. Retrieved from <http://www.natureword.com/tag/carrot-nutrition-table/>
13. Maangchi, 2012. Accessed June 2016 <http://www.Maangchi.Com/recipe/ponytail-kimchi>
14. Mheen, T.I., Kimchi fermentation and characteristics of the related lactic acid bacteria,
15. Mheen, T.I., and Kwon. T.W., Effect of temperature and salt concentration on kimchi fermentation. *Kor. J. food Sci. Technol.*, 16, 443-450 (1984)
16. Raymond J, 2016. world's healthiest foods: kimchi (korea) <http://www.Health.Com/health/article/0,,20410300,00.Html>
17. Suweon, 1981. Office of Rural Development (ORD), *Food Composition Table*, ORD.
18. Szalay J., 2015. What Are Carotenoids?, Live Science Contributor. <http://www.livescience.com/52487-carotenoids.html>



## Sensory Analysis of Carrot Kimchi

### Just about right test

Please indicate your opinion about the following characteristics of the sample.

#### 1. Size of the carrot

Much too small	Too small	Just about the right	Too large	Much too large

#### 2. Kimchi aroma

Much too little	Too little	Just about the right	Too strong	Much too strong

#### 3. Sourness

Much too little	Too little	Just about the right	Too sour	Much too sour

#### 4. Spiciness

Much too little	Too little	Just about the right	Too spicy	Much too spicy

#### 5. Crunchiness

Much too little	Too little	Just about the right	Too crunchy	Much too crunchy



## Sensory Analysis of Carrot Kimchi

### Just about right test

Please indicate your opinion about the following characteristics of the sample.

#### 1. Kimchi aroma

Much too little	Too little	Just about the right	Too strong	Much too strong

#### 2. Sourness

Much too little	Too little	Just about the right	Too sour	Much too sour

#### 3. Spiciness

Much too little	Too little	Just about the right	Too spicy	Much too spicy

The 9 point hedonic score of preference test

9 = Like extremely

8 = Like very much

7 = Like moderately

6 = Like slightly

5 = Neither like nor dislike

4 = Dislike slightly

3 = Dislike moderately

2 = Dislike very much

1 = Dislike extremely

#### 4. Overall liking \_\_\_\_\_

Comment \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

## Consumer Acceptance Survey

การสำรวจความพึงพอใจต่อผลิตภัณฑ์

“Carrot Kimchi”

“กิมจิแครอท”

This survey is a part of a special project (FT 4190) under a title “Carrot Kimchi” for Bachelor of Science Degree. This survey aims to study the consumer’s behaviors, attitudes, and needs toward a development of Carrot Kimchi. Please kindly complete the questions by checking in the provided spaces.

แบบสำรวจความพึงพอใจชิ้นนี้เป็นส่วนหนึ่งของวิชาโครงการงานพิเศษ เพื่อจบการศึกษาในระดับวิทยาศาสตร์บัณฑิตภายใต้เรื่องการพัฒนาผลิตภัณฑ์กิมจิแครอท เพื่อศึกษาพฤติกรรมของผู้บริโภค ทักษะ และความต้องการที่มีต่อผลิตภัณฑ์กิมจิแครอท กรุณาตอบคำถามโดยการกาเครื่องหมาย ✓ ในช่องว่าง

### Part 1 : Demographic information

1. Gender (เพศ)

☐ Female

☐ Male

2. Age (อายุ)

☐ Less than 20 years old

☐ 40 – 49 years old

☐ 20 – 29 years old

☐ 50 – 59 years old

☐ 30 - 39 years old

☐ 60 years old and over

3. Occupation (อาชีพ)

☐ Student

☐ Teacher

☐ Housewife

☐ Government Officer

☐ Employee

☐ Own business

☐ Other \_\_\_\_\_

4. Nationality (สัญชาติ)

☐ Thais

☐ Non – Thai

5. Income (รายได้)

☐ 5,000 baht

☐ 10,001 – 15,000 baht

☐ 5,000 – 10,000 baht

☐ 15,000 baht



Part 2 : Basic information of consumer's behavior on Kimchi.

1. Do you eat vegetable? (คุณรับประทานผักหรือไม่)

☐ Yes

☐ No

2. Do you like to eat pickled vegetable? (คุณชอบรับประทานผักดองหรือไม่)

☐ Yes

☐ No

3. What kind of pickled vegetable have you ever tried? (คุณเคยรับประทานผักดองชนิดใดบ้าง)

☐ Cucumber

☐ Cabbage

☐ Carrot

☐ Radish

4. Have you had Kimchi before? (คุณเคยรับประทานกิมจิหรือไม่)

☐ Yes

☐ No

5. Where do you buy Kimchi? (คุณหาซื้อกิมจิจากที่ไหน)

☐ Convenience store

☐ Grocery store

☐ In a Korean restaurant

☐ Local market

☐ Supermarket

☐ Other \_\_\_\_\_

6. How often do you buy Kimchi? (คุณซื้อกิมจิบ่อยแค่ไหน)

- ☐ Everyday
- ☐ Once per week
- ☐ 2-3 times per week
- ☐ Once per month
- ☐ 2-3 times per month
- ☐ less than once per month

7. If there is a new type of Kimchi launch into the market, are you interested? (ถ้าหากมีกิม

จินิคใหม่วางจำหน่ายในตลาด คุณสนใจหรือไม่)

- ☐ Yes
- ☐ No



Part 3 : Information of consumer's product behavior on product

Instruction : Please test the product and answer the following question.

Please rate the product using the 9 – point Hedonic scale below

(กรุณากรอกคะแนนความพึงพอใจต่อผลิตภัณฑ์ กิมจิแครอท)

9 = Like Extremely

4 = Dislike Slightly

8 = Like Very Much

3 = Dislike Moderately

7 = Like Moderately

2 = Dislike Very Much

6 = Like Slightly

1 = Dislike Extremely

5 = Neither Like or Dislike

3.1 Score \_\_\_\_\_

3.2 Do you accept Carrot Kimchi? (คุณยอมรับผลิตภัณฑ์กิมจินี้หรือไม่)

☐ Accept

☐ Not Accept

3.3 Would you buy this product if it is sold in the market? (หากมีการวางจำหน่ายผลิตภัณฑ์ชิ้นนี้ในตลาด คุณจะซื้อหรือไม่)

☐ Yes

☐ No



3.4 What is your reasonable price for 50 grams of carrot kimchi for 5 sticks? (ราคาที่เหมาะสมสำหรับแครอทปริมาณ 5 ชิ้น)

- ☐ Lower than 25 baht
- ☐ 36 to 45 baht
- ☐ 26 to 35 baht
- ☐ More than 45 baht

Suggestion \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



RCBD : kimchi carrot in different hours of fermentation

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Treatment	2	27.39	13.694	9.610	0.000197
Replication	44	182.06	4.138	2.904	2.6905



# Duncan's new multiple range tests for time during fermentation

Alpha	0.05
Error Degree of Freedom	117
Error Mean Square	2.445109

Number of Mean	2	3
Critical Range	0.7051713	0.7421515

Duncan grouping	Mean	N	Sample
A	6.233	15	24hrs
A			
A	6.067	15	48hrs
B	5.156	15	72hrs



## Calculation % acidity

1. Transfer acid solution 20 ml. into Erlenmeyer flask
2. Add few drops of phenolphthalein
3. Titrate with standard NaOH to the end point, turn to pink color
4. Calculate % acidity

$$\% \text{ Lactic acid} = \frac{\text{mol NaOH} \times V \text{ NaOH (ml.)} \times \text{MW} \times 100}{1000 \times V \text{ Sample (ml.)}}$$

mol. NaOH = 0.1 N.

V NaOH = depend on result

MW lactic acid = 90.08

V sample = 20 ml.

$$\% \text{ Lactic acid} = \frac{0.1 \times 1.1(\text{ml.}) \times 90.08 \times 100}{1000 \times 20 (\text{ml.})}$$

# Texture Analysis

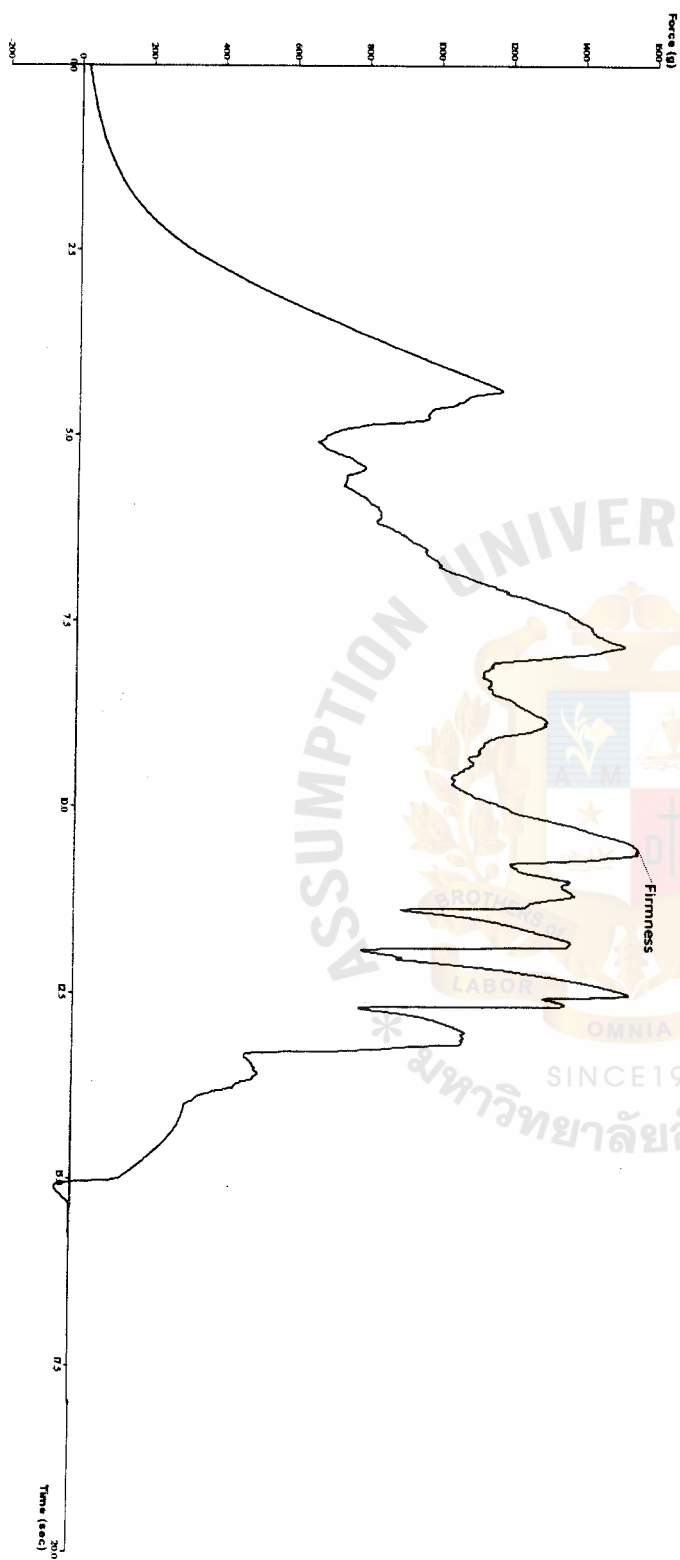
Warner Blatzler blade cutting

Test ID	Firmness	Toughness
	g	g.sec
	Force 1	Area F-T 1:2
Start Batch carrot kimchi_		
carrot kimchi_2	1325.115	11648.516
carrot kimchi_3	5157.259	23872.118
carrot kimchi_4	2585.484	16112.174
carrot kimchi_5	3456.798	19530.591
carrot kimchi_6	1573.963	12273.065
carrot kimchi_7	1625.692	9295.729
carrot kimchi_8	1779.609	14679.71
carrot kimchi_9	2380.53	11298.998
carrot kimchi_10	4217.282	24158.786
carrot kimchi_1	2376.268	16400.705
End Batch carrot kimchi_		
Average:	2647.8	15927.039
S.D.	1194.373	4926.828
C.V.	45.108	30.934

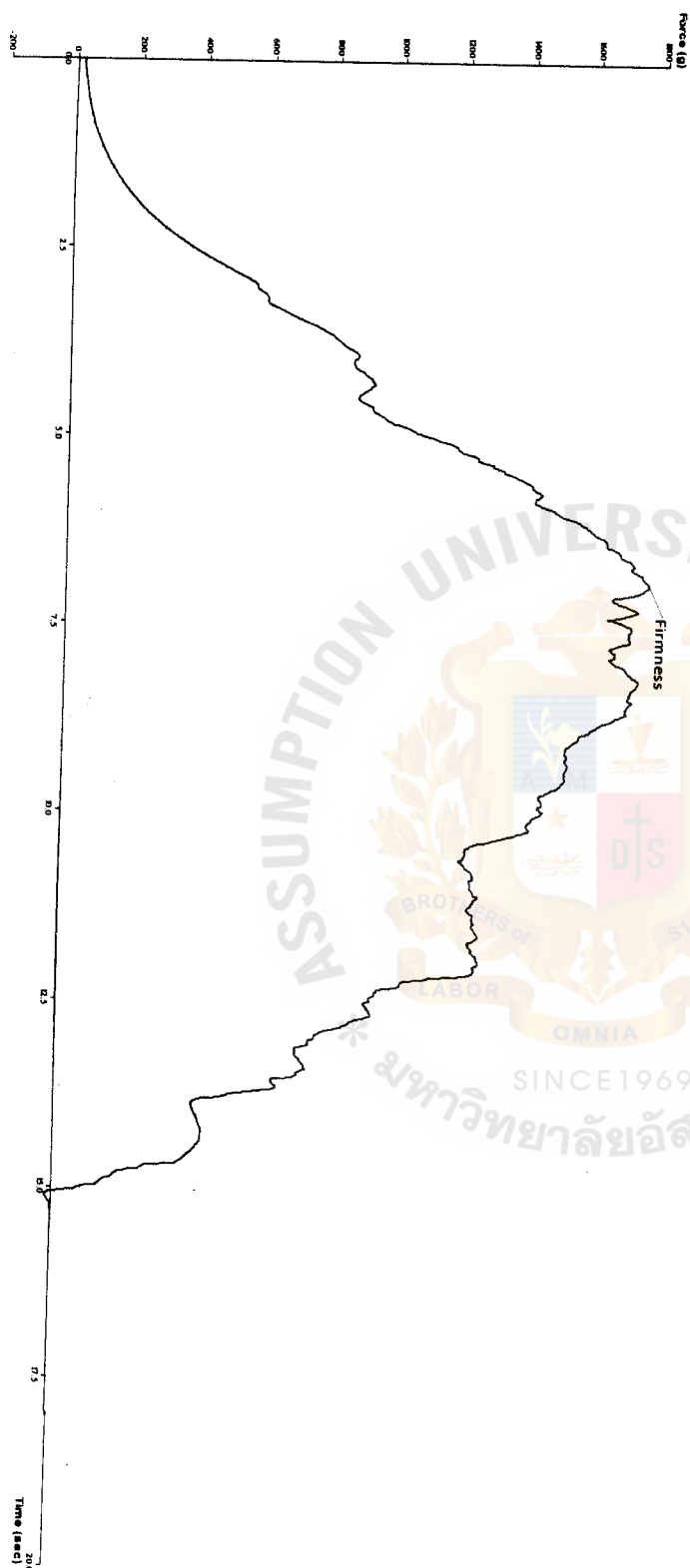
P2 - 5 mm cylinder probe

Test ID	Force 1	Hardness	Springiness	Cohesiveness	Chewiness
	g	g			
	Force 1	Force 2	J#/F#	I#/G#	P#*N#
Start Batch					
TPAcarrotKimchi_					
TPAcarrotKimchi_1	3912.789	10501.04	0.321	0.064	214.048
TPAcarrotKimchi_2	4985.83	13170.16	0.353	0.059	276.645
TPAcarrotKimchi_3	2986.636	17065.44	0.272	0.03	139.471
TPAcarrotKimchi_4	2843.318	12959.1	0.306	0.043	169.225
TPAcarrotKimchi_5	4637.674	11761.75	0.319	0.077	289.439
TPAcarrotKimchi_6	6514.287	24443.09	0.34	0.063	525.649
TPAcarrotKimchi_7	4059.563	10295.97	0.303	0.074	229.276
TPAcarrotKimchi_8	6620.739	7990.554	0.203	0.489	790.996
TPAcarrotKimchi_9	5181.337	9606.914	0.337	0.091	295.531
TPAcarrotKimchi_10	6146.084	15613.6	0.211	0.064	212.11
TPAcarrotKimchi_11	5583.066	21687.1	0.263	0.057	324.607
TPAcarrotKimchi_12	4005.646	15078	0.405	0.05	306.178
TPAcarrotKimchi_13	4292.167	13429.27	0.297	0.059	236.254
End Batch					
TPAcarrotKimchi_					
Average:	4751.472	14123.23	0.302	0.094	308.418
S.D.	1231.39	4739.882	0.056	0.12	173.071
Coef. of Variation	25.916	33.561	18.409	127.429	56.116





Source: Sample 10





0

0

0

0

0

Time (sec)

